



MIT International Center for Air Transportation

Interactive Electronic Flight Strips

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Agenda

- **Motivation**
- **Design Process**
- **Current Design and Sample Scenario**
- **Unresolved Issues, Current Progress, and Future Work**



Motivation

- **Controller interface needed for MIT departure planner**
- **System architecture and design driven by requirements analysis**
 - ☐ Functional (controller input-output)
 - ☐ Human factors



DP Interface

Functional Requirements

- **Controller Input**

- ☐ Aircraft “ready to push” time
- ☐ Aircraft push time
- ☐ Aircraft taxi start time
- ☐ Aircraft takeoff time
- ☐ Aircraft gate location
- ☐ Current runway configuration
- ☐ Downstream constraints

- **Controller Output**

- ☐ Suggested runway configuration changes (configuration manager)
- ☐ Pushback queue and initial runway assignments (gate manager)
- ☐ Virtual runway queue and takeoff times (virtual queue and mix managers)

- **All other DP input from static databases (e.g., airport layout) or other sources (e.g., weather forecasts, host, surface surveillance)**



DP Interface

Human Factors Requirements

- Minimize head-down time
- Maintain mobility within tower cab

Observations

- **Some DP inputs already written on paper flight strips**
 - ☐ “Ready to push” time
 - ☐ Actual push time (if different from “Ready to push”)
 - ☐ Takeoff time
- **Some aircraft-specific DP inputs would be easy to add to a flight strip**
 - ☐ Taxi start time
 - ☐ Gate location
- **Other DP inputs and outputs better suited to centralized interface**
 - ☐ Current runway configuration
 - ☐ Suggested runway configuration changes
 - ☐ Downstream restrictions
 - ☐ Runway, Taxi, and Push queues

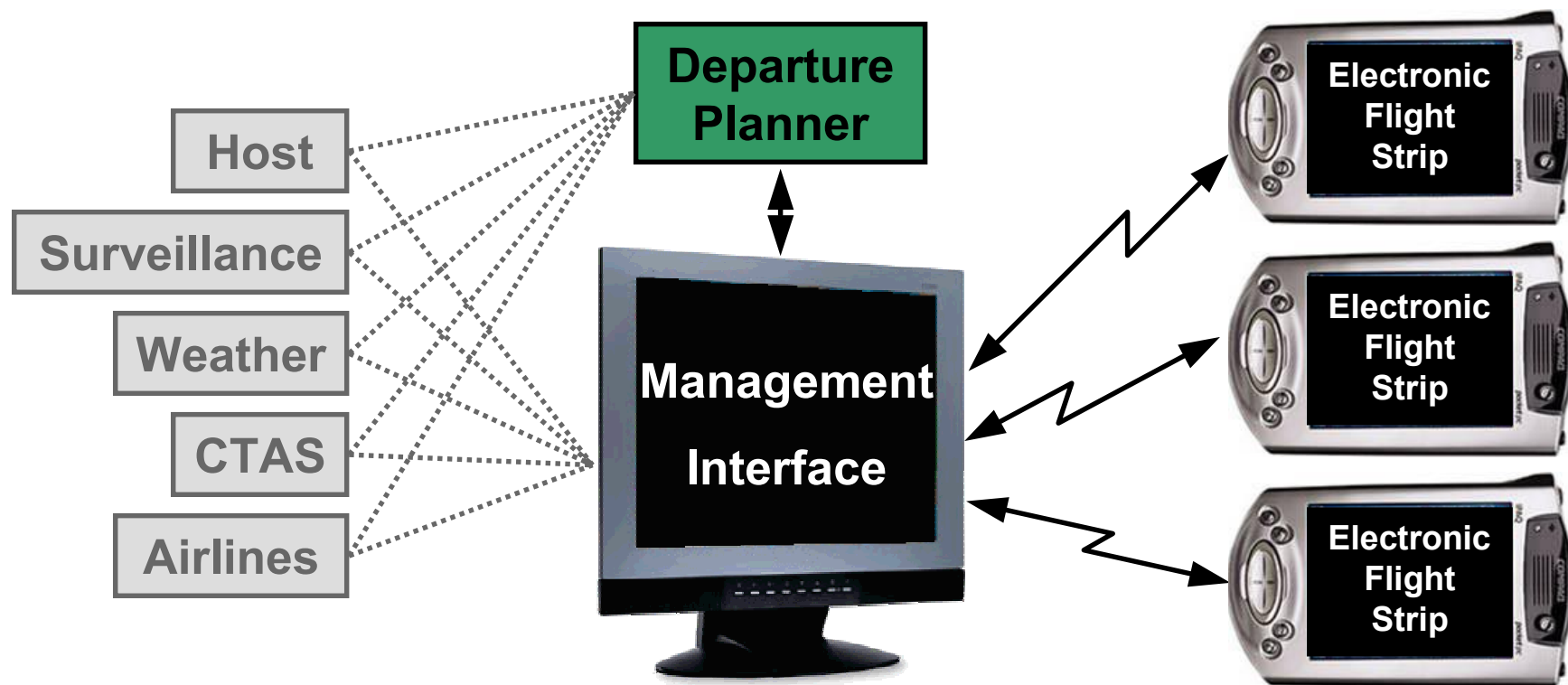
DAL306	5177	DFW	DFW DALL6 EIC HRV J58		
H/B763/E	P1815		COVIA PIE MINEE3 MCO		
789	370				



System Architecture Conclusions

- **To satisfy all interface functional requirements**
 - ☐ Electronic flight strip system
 - ☐ Central management interface
- **To satisfy human factors requirements of tower environment**
 - ☐ An electronic analogue of the individual paper flight progress strip is needed, not just an electronic analogue of the strip rack
- **Solution: PDA-based electronic flight strips communicating over wireless LAN with desktop-based central management interface**

System Architecture



- One electronic device per flight strip



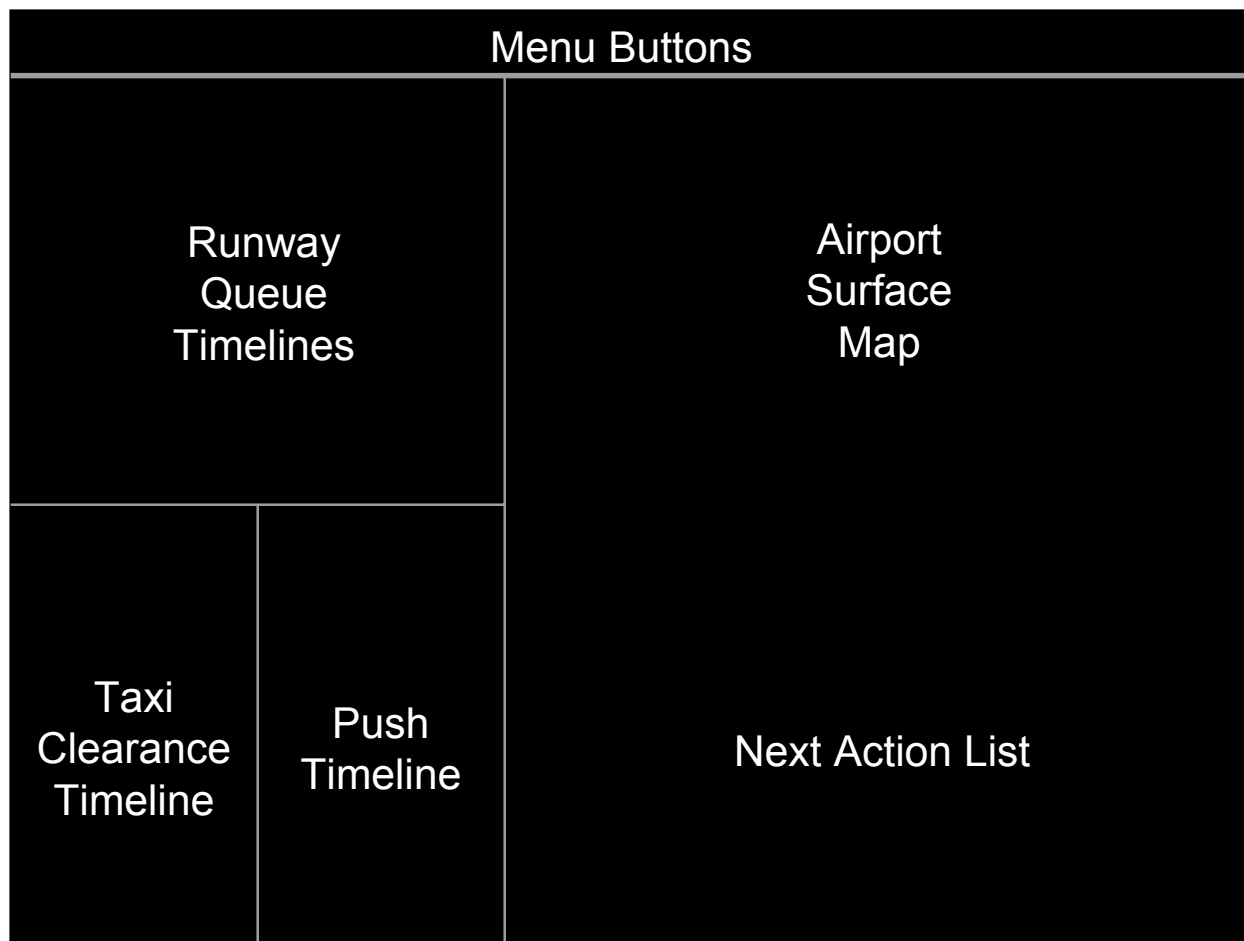
Design Considerations

- **Electronic flight strip must preserve functionality present in current paper departure flight strips (source: BOS Tower SOP)**
 - ☐ Changing aircraft type, altitude, route, etc.
 - ☐ Recording initial heading
 - ☐ Recording ready to push and departure times
 - ☐ Recording in-trail restrictions
 - ☐ Recording nonstandard taxi paths
 - ☐ Indicating wake turbulence waiver
 - ☐ Indicating ATIS received by aircraft
 - ☐ Indicating position and hold clearance issued
 - ☐ Writing any other nonstandard instructions
- **Other aspects of paper flight strips and strip rack that should be preserved**
 - ☐ Handoffs completed by physically transferring strip from controller to controller
 - ☐ Ability to sort flights in strip rack



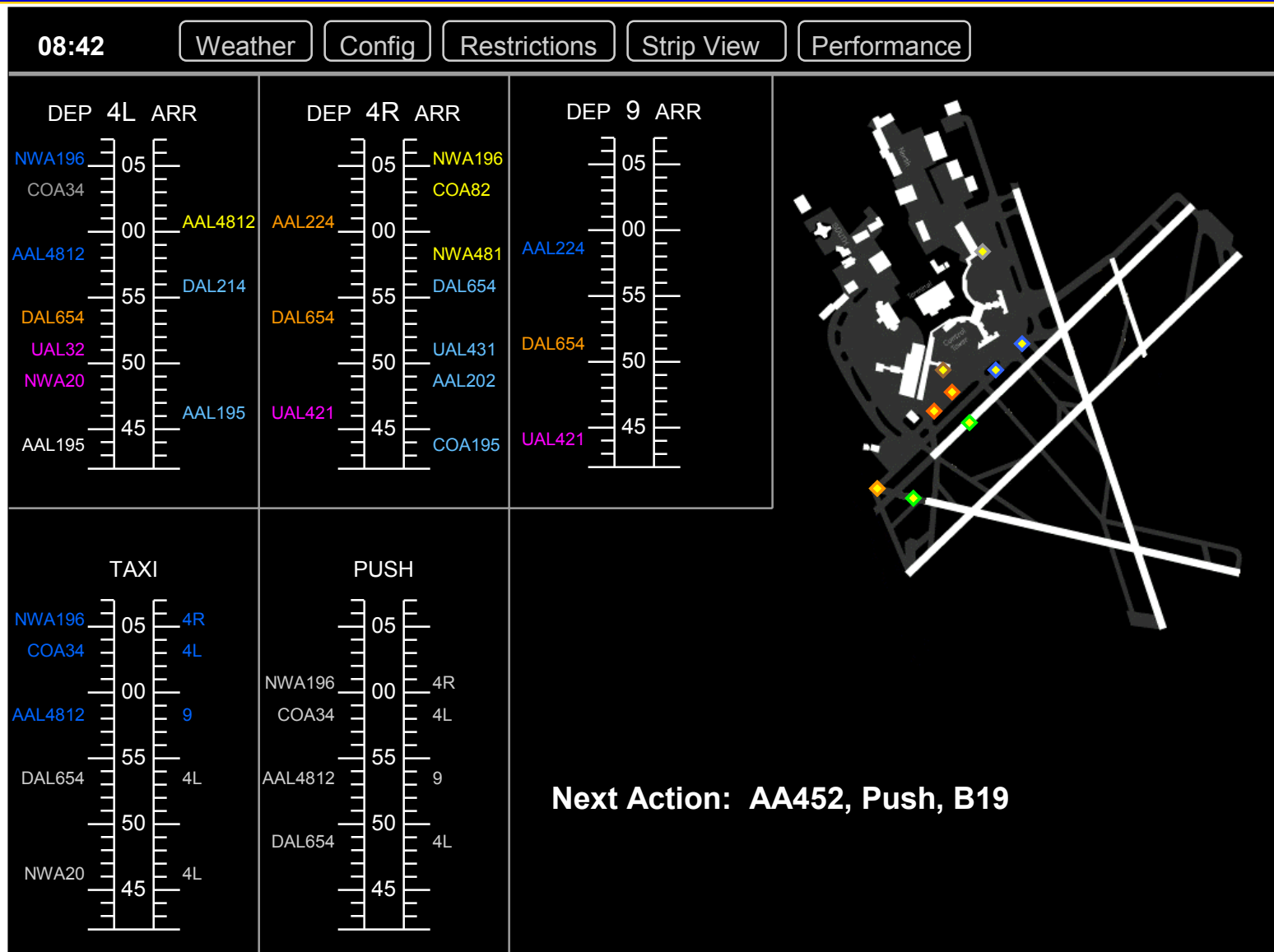
Management Interface: General Layout

- Management interface provides airport-centric view of operations





Management Interface





Flight Strip: General Layout

- Electronic flight strip shows paper flight strip data and aircraft-centric view of operations





Flight Strip: Example Screen



Color Coding

- **Callsign**

- ☐ No clearance
- ☐ Cleared for push
- ☐ Cleared for taxi to runway
- ☐ Cleared for taxi with hold short point
- ☐ Cleared for position and hold
- ☐ Cleared for takeoff

DAL306

DAL306

DAL306

DAL306

DAL306

DAL306

- **Clearance Buttons**

- ☐ “Wait For” event not yet occurred
- ☐ All “Wait For” events occurred

Taxi 18L

Taxi 18L

- **Critical “Wait For” event**

- ☐ Underlined in red

MIT: EIC 5/20



Interactivity

- **Controller – Management Interface**

- ☐ Drag and drop aircraft on timelines to resequence

- **Controller – Flight Strip**

- ☐ To change altitude, heading, runway, etc: tap box, choose from pop-up list of choices, or scroll through possible choices with up/down hardware buttons, then tap “accept” or “cancel” soft buttons
- ☐ To issue clearance: tap clearance soft button
- ☐ To undo last clearance: tap “undo” soft button
- ☐ To view full event history: hold stylus over “events” soft button

- **Management Interface – Flight Strip**

- ☐ When flight strip is picked up / hardware button pressed, aircraft is highlighted on map display and management interface timelines
- ☐ When aircraft is selected on management interface, flight strip is highlighted in some way (reverse video, flashing screen, etc.)



Flight Strip: Aircraft at Gate

A handheld device screen, likely a PDA or early smartphone, displaying a flight strip for aircraft DAL306. The device has a silver-colored casing with a large circular navigation pad on the left and several buttons on the right. The screen is black with white text. The flight strip information is organized into a table-like structure. The aircraft details include DAL306, H/B763/E, and 5177. The gate is B19, and the flight path is DFW DALL6 EIC HRV J58 COVIA PIE MINEE3 MCO. The event log shows ReadyPush at 11:37 / #2, Push at 11:42 / #5, Taxi at 11:45 / #6, and Takeoff at 11:55 / #10. The current time is 11:35, and there is an Undo button at the bottom right. The device is labeled "i-ma" and "COMPAQ pocket pc" on the right side.

DAL306	B19			
H/B763/E	18L		11000	370
5177	DFW DALL6 EIC HRV J58			
	COVIA PIE MINEE3 MCO			
Event	Time/Seq	Wait For	Action	
ReadyPush	11:37 / #2		Call Ready	
Push	11:42 / #5	NWA020		
Taxi	11:45 / #6	UAL237		
Takeoff	11:55 / #10	<u>MIT: EIC - 0/20</u> DEP: UAL237		
	11:35		Undo	



Flight Strip: Aircraft Ready to Push

A handheld device screen, likely a PDA or early smartphone, displaying a flight strip. The device has a silver-colored casing with a large circular navigation pad on the left and several buttons on the right. The screen is black with white text. The flight strip is for flight DAL306, showing its route from DFW to MCO via DALL and HRV. It also lists other flights in the sequence: NWA020, UAL237, and MIT: EIC - 0/20. The current time is 11:39. A yellow button labeled "Clear Push" is visible next to the "Push" event.

DAL306	B19			
H/B763/E	18L		11000	370
5177	DFW DALL6 EIC HRV J58			
	COVIA PIE MINEE3 MCO			
Event	Time/Seq	Wait For	Action	
Push	11:42 / #3	NWA020	Clear Push	
Taxi	11:45 / #4	UAL237		
Takeoff	11:55 / #8	<u>MIT: EIC - 0/20</u> DEP: UAL237		
	11:39	Undo		

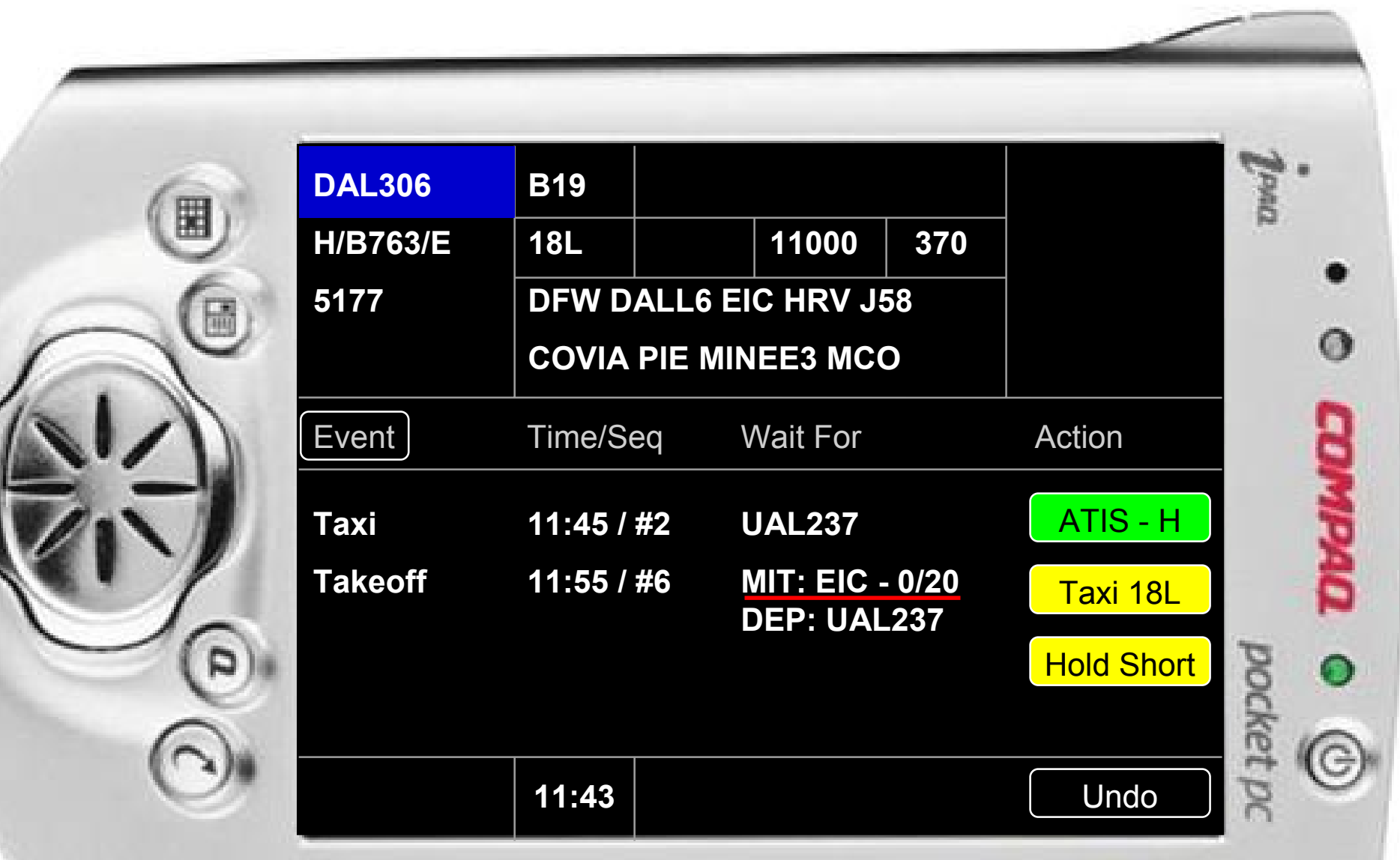


Flight Strip: Aircraft #1 for Push





Flight Strip: Aircraft Pushed





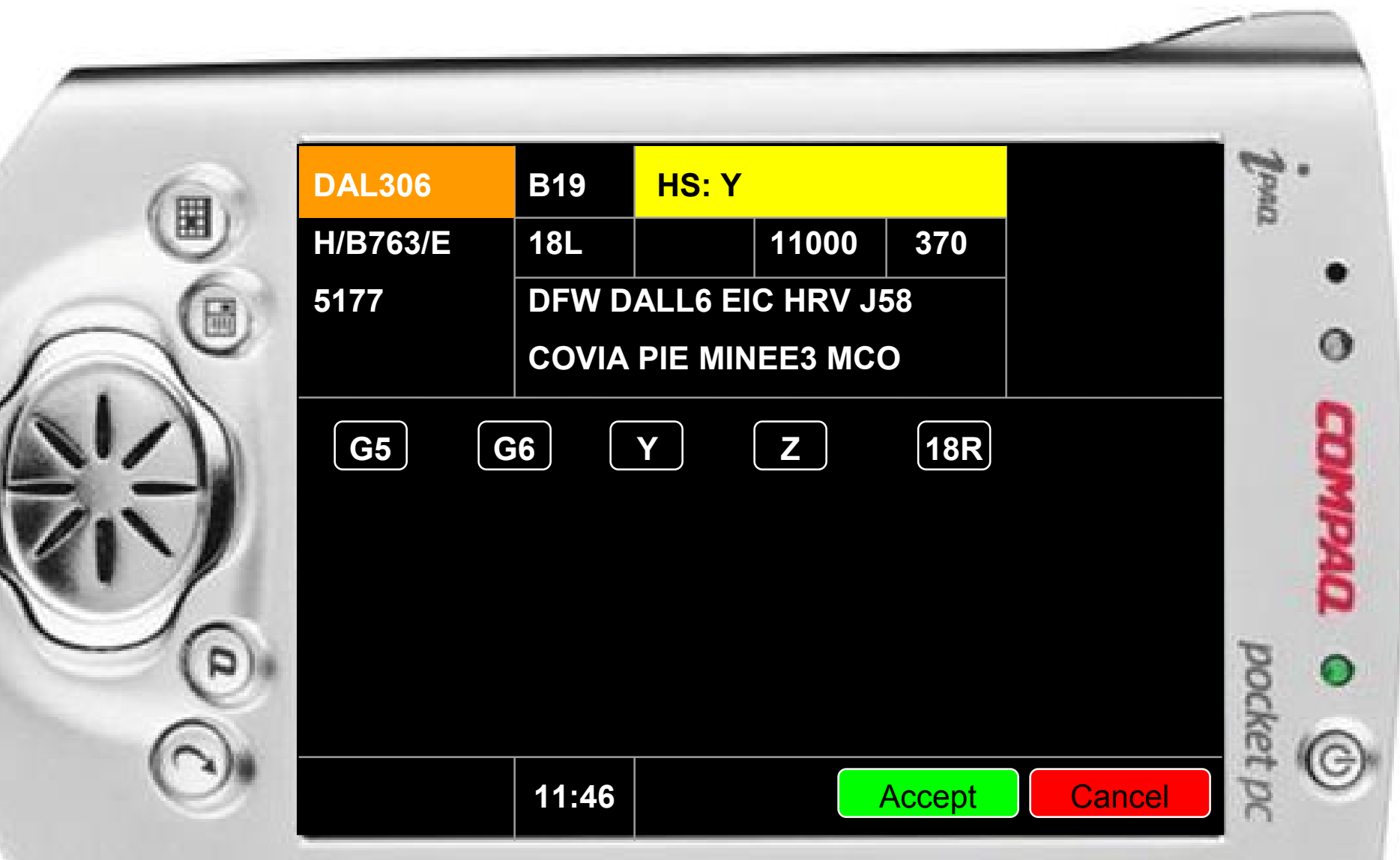
Flight Strip: Aircraft #1 for Taxi

A handheld electronic device, identified as a 'pocket pc' and 'COMPAQ' on the right side, is shown. The screen displays a flight strip for 'Aircraft #1'. The device has a large circular navigation pad on the left and several buttons. The flight strip is divided into sections for flight details and a sequence of events.

DAL306	B19				
H/B763/E	18L		11000	370	
5177	DFW DALL6 EIC HRV J58				
	COVIA PIE MINEE3 MCO				
Event	Time/Seq	Wait For	Action		
Taxi	11:45 / #1	UAL237	Taxi 18L		
Takeoff	11:55 / #5	<u>MIT: EIC - 0/20</u> DEP: UAL237	Hold Short		
	11:45	Undo			

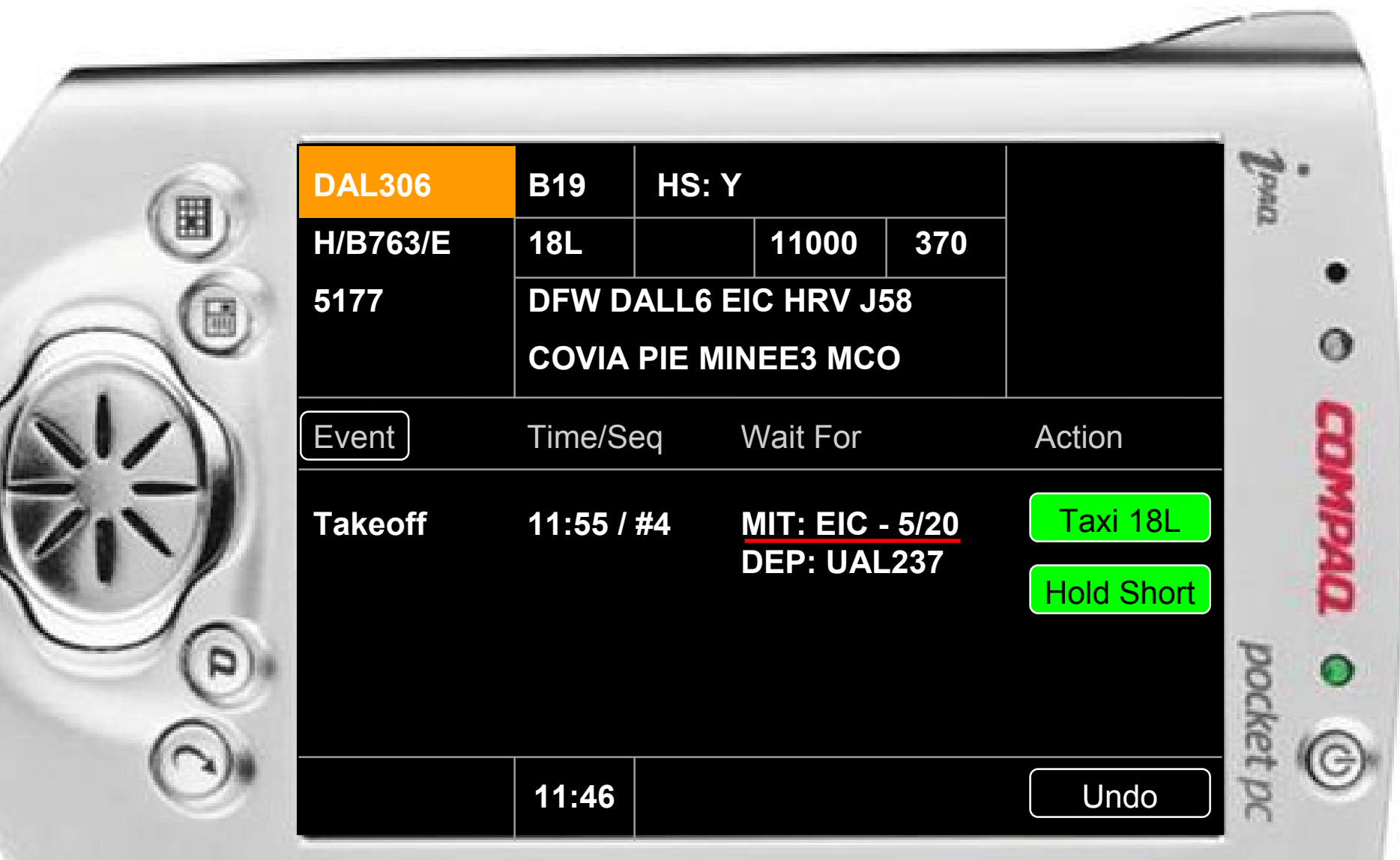


Flight Strip: Selecting Hold Short Point



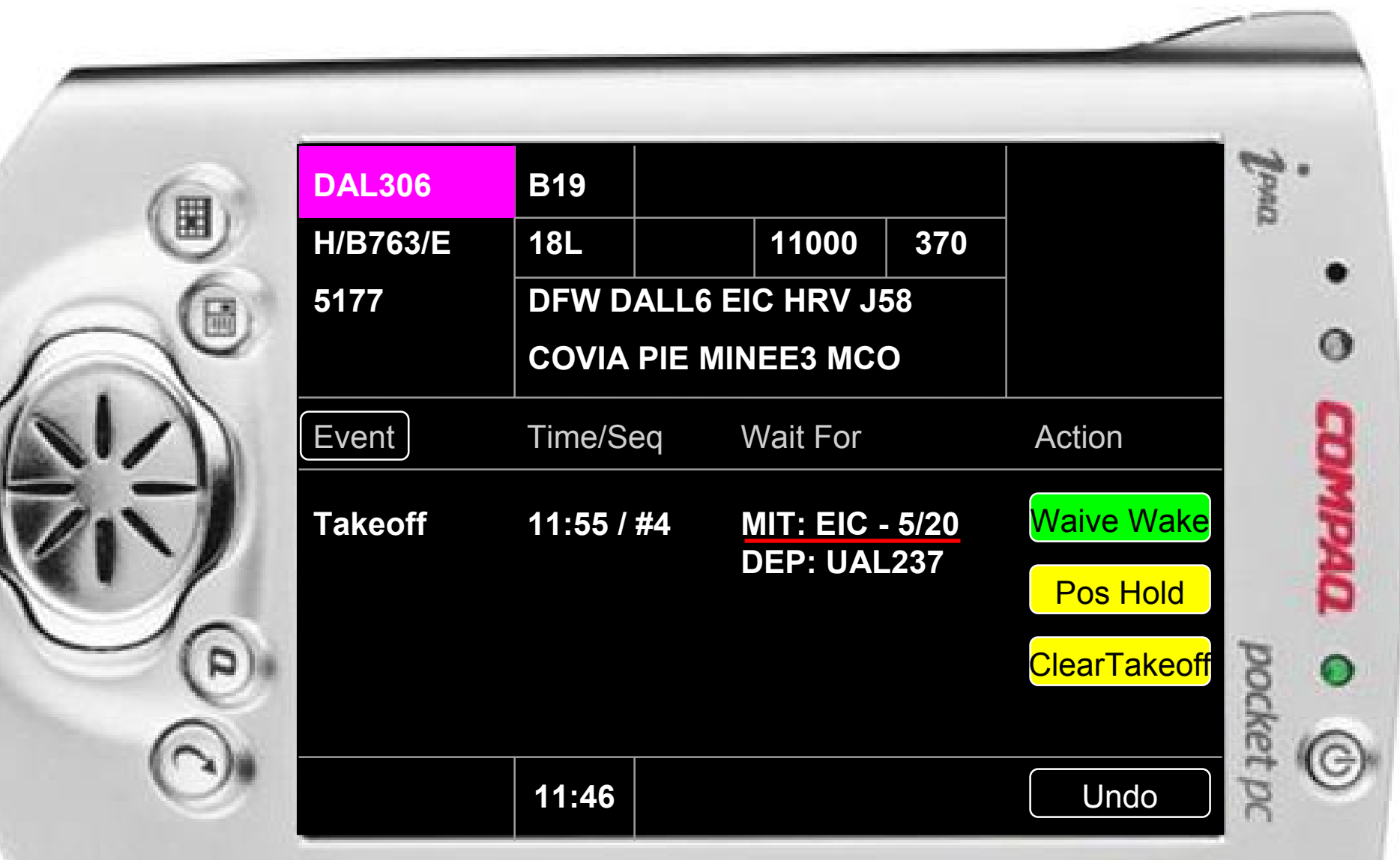


Flight Strip: Aircraft at Hold Short Point



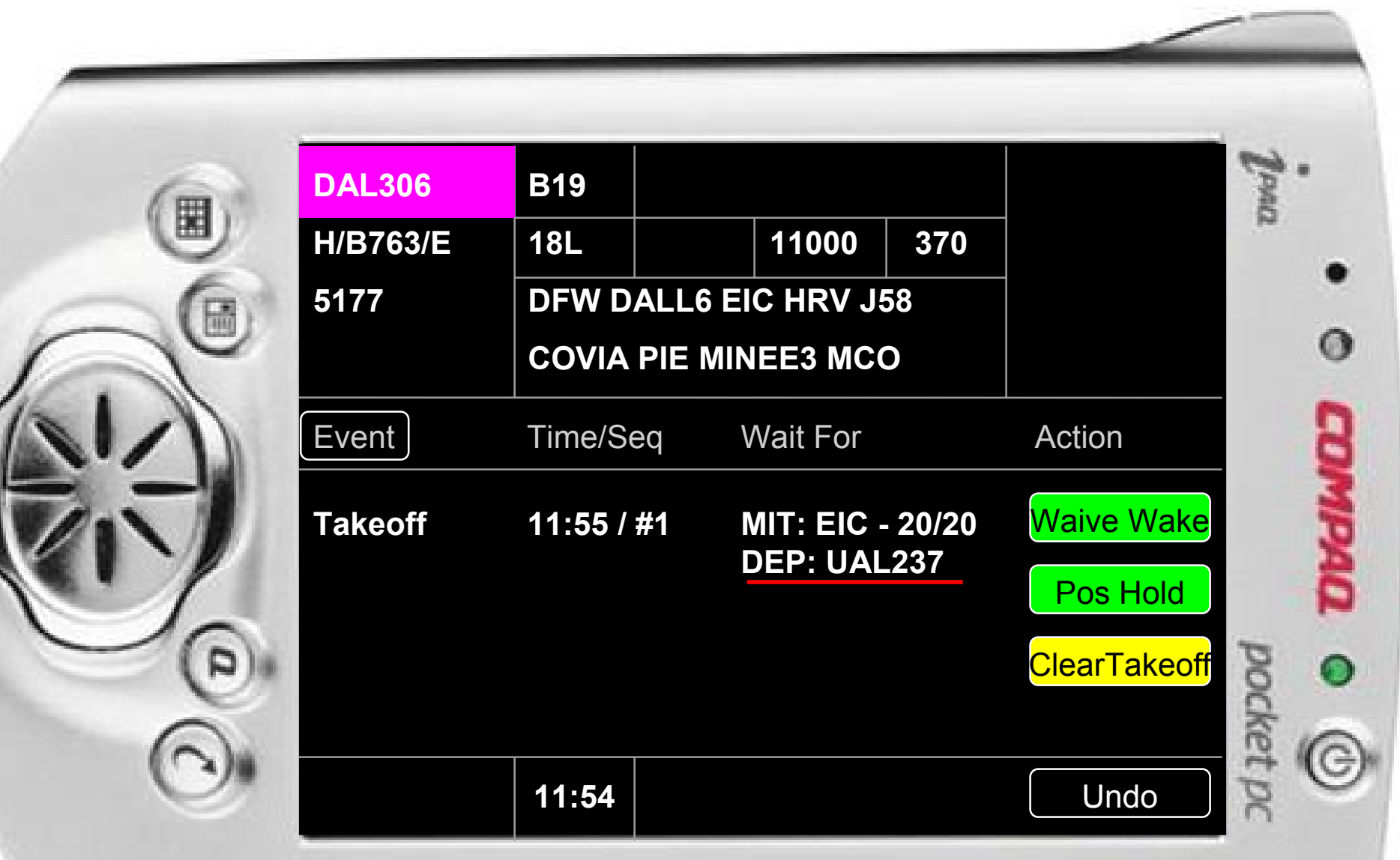


Flight Strip: Aircraft Taxiing





Flight Strip: Aircraft #1 for Takeoff, Waiting for Departure Aircraft





Flight Strip: Aircraft #1 for Takeoff, Initial Heading Selection





Unresolved Issues

- **Sequence-based vs. time-based planning**
- **Absolute vs. differential time**
- **Color conventions**
- **What is the important information to show for each “Wait For” event**
 - ☐ EDCT
 - ☐ DSP
 - ☐ APREQ
 - ☐ MIT
 - ☐ MINIT
 - ☐ Aircraft to Follow



Current Progress

- **Application running on PDAs showing current design with partial functionality**
 - ☐ Displays flight strip data
 - ☐ Heading and altitude can be modified
 - ☐ Sends data over wireless LAN to management interface



Future Work

- **Finish coding initial design of flight strips and management interface**
- **Solicit input on interface from Boston Logan controllers**
- **Revise design based on controller input**
- **Evaluate controller performance with electronic flight strips**